Solubility

Not all ionic compounds dissolve!

Instead of doing experiments all the time to see which ones will dissolve, we use <u>The solubility rules.</u>

Solubility Rules

1. All nitrates (NO_3^-) are **soluble**.
2. All ammonium (NH_4^+) or alkali (Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+) compounds are **soluble**.
3. All carbonates (CO_3^{2-}), phosphates (PO_4^{3-}) and hydroxides (OH^-) are **insoluble** except with the cations in Rule #2.
4. All chlorides (Cl^-), bromides (Br^-), and iodides (I^-), are **soluble** except with Ag^+, Pb^{2+}, or Hg^+.
5. All sulphates (SO_4^{2-}) are **soluble** except with Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}, Pb^{2+},

Practice

Which of the following are soluble in water?

1. **$SrSO_4$**
2. **$NaNO_3$**
3. **$PbCl_2$**

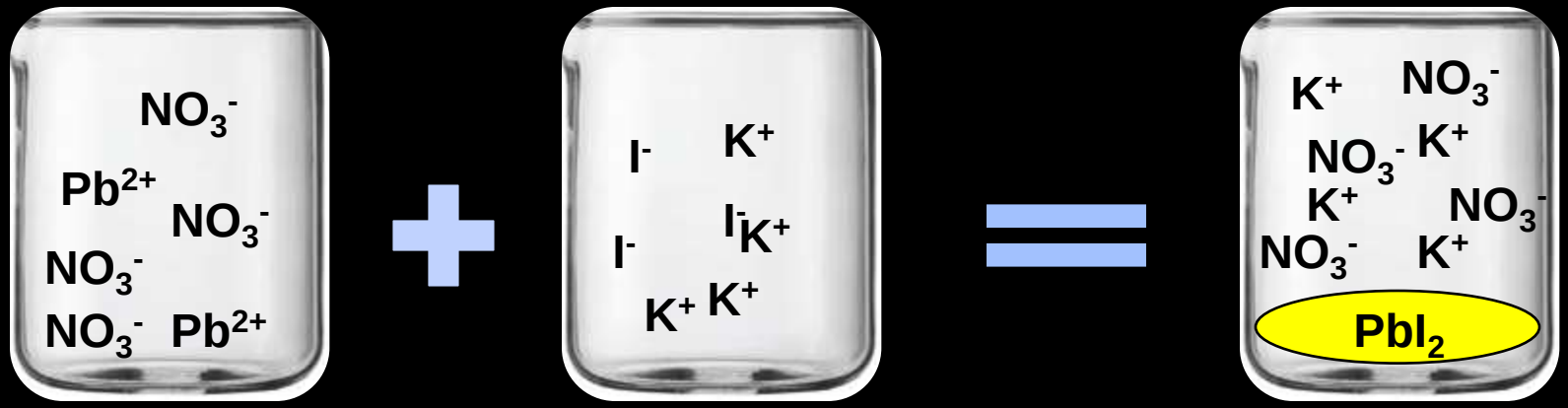
Predict the products of the following reaction: (if no solid precipitate is formed, there is no rxn)

$Pb(NO_3)_2(aq) + KI\ (aq) \rightarrow$

$Pb(NO_3)_2(aq) + 2KI\ (aq) \rightarrow PbI_2(s) + 2KNO_3\ (aq)$

We know it is a solid precipitate because it is insoluble according to the solubility rules.

View of the Rxn Ions



Because K^+ and NO_3^- remain dissolved, they are called spectator ions and are not included in the net ionic equation.

Net Ionic Equation

$$Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$$

Solubility Practice

Which are soluble

KCl

NH_4NO_3

AgCl

$CaSO_4$

Li_2SO_4

Precipitation Reactions

When a solid doesn't dissolve it is called insoluble.

A solid that forms when two solutions are mixed is called a precipitate.

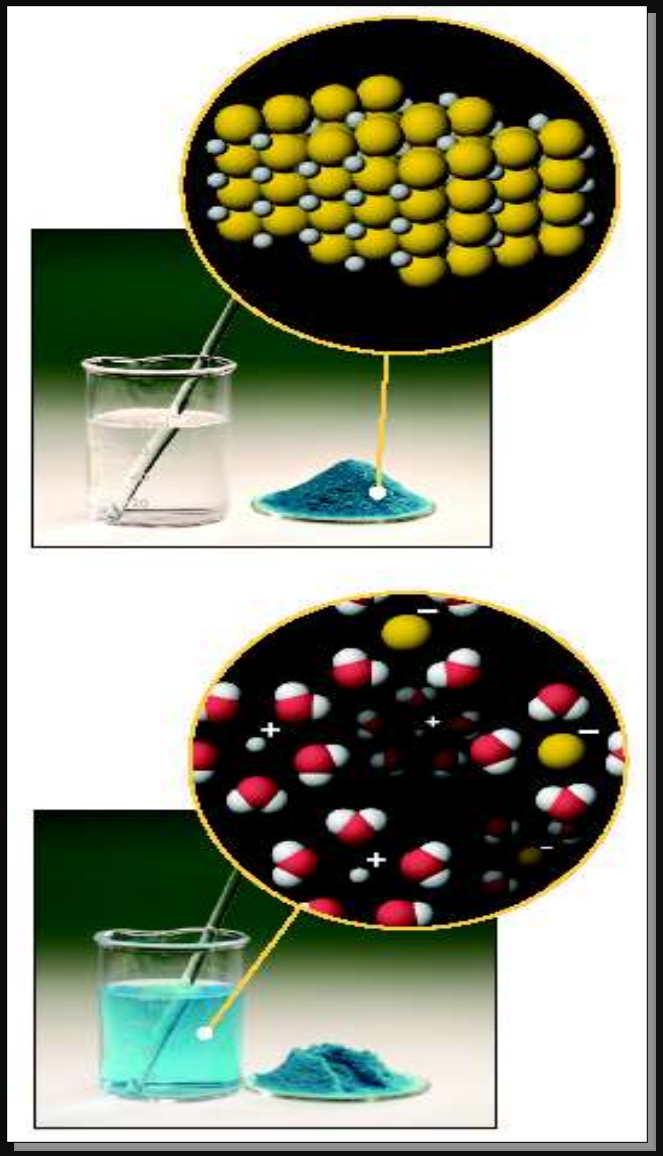
Denoted as (s) in a chemical equations

Solution Quick Review

http://www.youtube.com/watch?v=9h2f1Bjr0p4

Some Definitions

A solution is formed when a **Solvent** _____ and **Solute** _____ are mixed.



PARTS OF SOLUTIONS

SOLUTE –part of a solution that is being dissolved (usually the lesser amount)

SOLVENT –part of a solution that dissolves the solute (usually the greater amount)

Solute + Solvent = Solution

Definitions

Solutions can be **saturated** or **unsaturated**.

Saturated solution contain the maximum amount of solute.

An **unsaturated** solution contains less solute than a solvent can hold at a particular temp.

Definitions

SUPERSATURATED SOLUTIONS contain more solute than a solvent can hold

They are unstable. The super saturation is only temporary, and usually accomplished in one of two ways:

To Make a Supersaturated Solution

1. **Warm the solvent so that it will dissolve more, then cool the solution**
2. **Evaporate some of the solvent carefully so that the solute does not solidify and come out of solution.**

Supersaturated Rock Candy

This supersaturated sucrose and food coloring solution uses a "seed" crystal to make…

Crystal Rock candy

Agenda:

- **Polarity**
- **Molarity**

Objective: You will UNDERSTAND how to calculate molarity, and APPLY your knowledge to making solutions

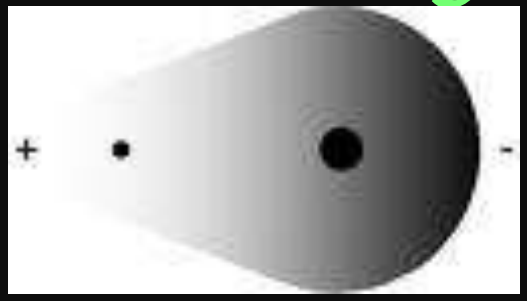
Factors affecting solubility

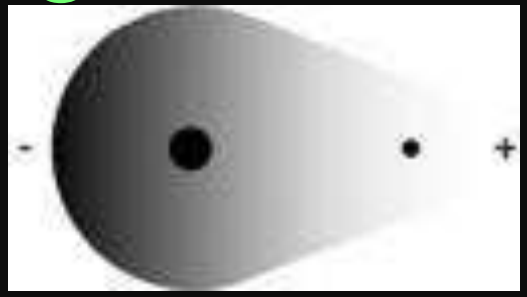
1. Heat increases solubility in most liquids

   * solubility of gases are greater in cold water than hot.

2. True: the solubility of gas increases w/ increasing pressure

Factors affecting solubility





3. Polar molecules will only dissolve in Polar molecules

Non- polar molecules will only dissolve in non-polar molecules

"like dissolves like"

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

1. agitation helps a solute to dissolve because it brings fresh solvent into contact w/ the solute
2. A greater Surface area of solute is exposed to the colliding water molecules

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

3. Energy also influences the rate at which a substance dissolves. The higher energy leads to increased frequency and number of the collision of water molecules w/ crystal surfaces

Question

A solution is made up of 25 grams of cyclohexane (non-polar) and 7 grams of acetonitrile (polar).

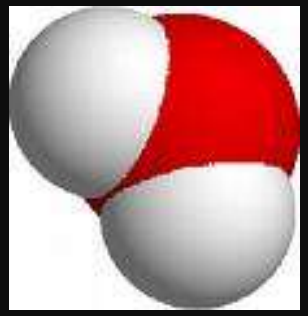
What is the solute ?

What is the solvent?

Would you expect the solvent to readily mix with the solute?

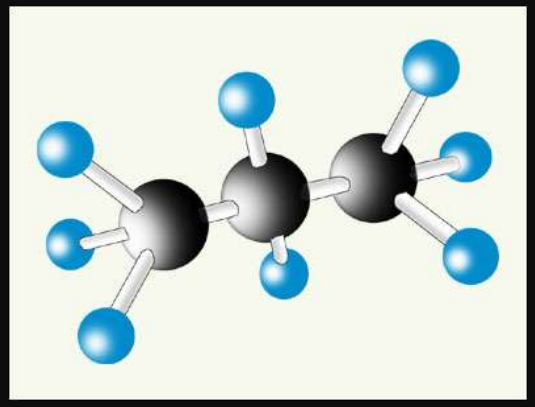
Polarity

"polar" molecules: An uneven distribution of electron density. Ex. water H_2O



“non polar” molecules: an even distribution of electron density.

Ex. Oil, propane, etc.



http://www.youtube.com/watch?v=PVL24HAesnc

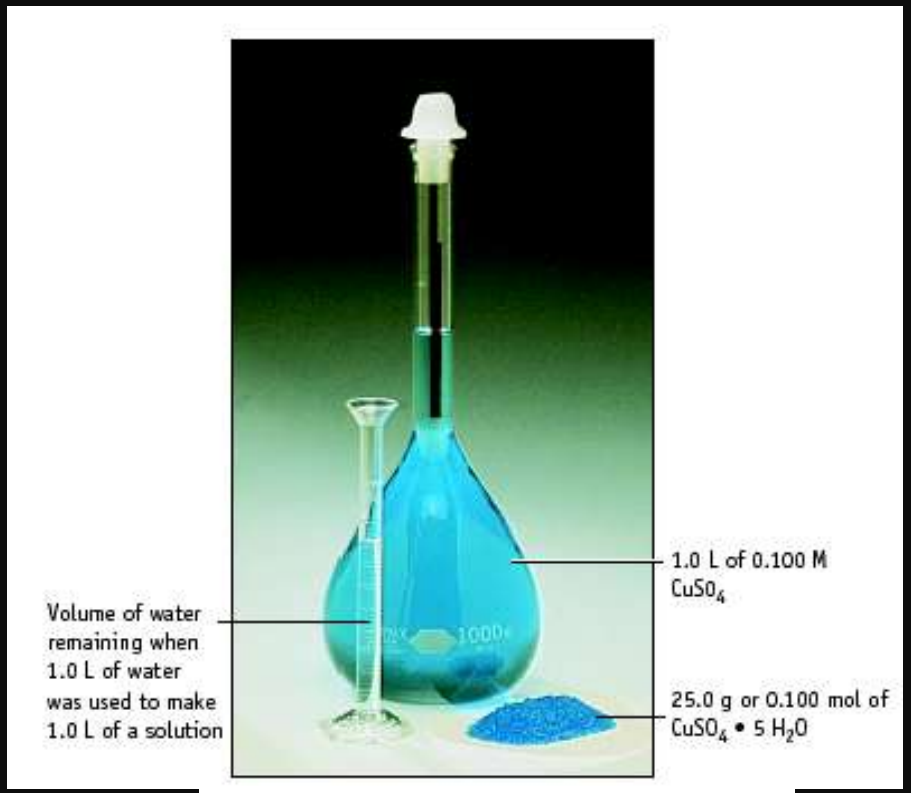
http://www.youtube.com/watch?v=LKAjTE7B2x0&feature=related

Concentration of a solution

The amount of solute in a solution is given by its concentration.

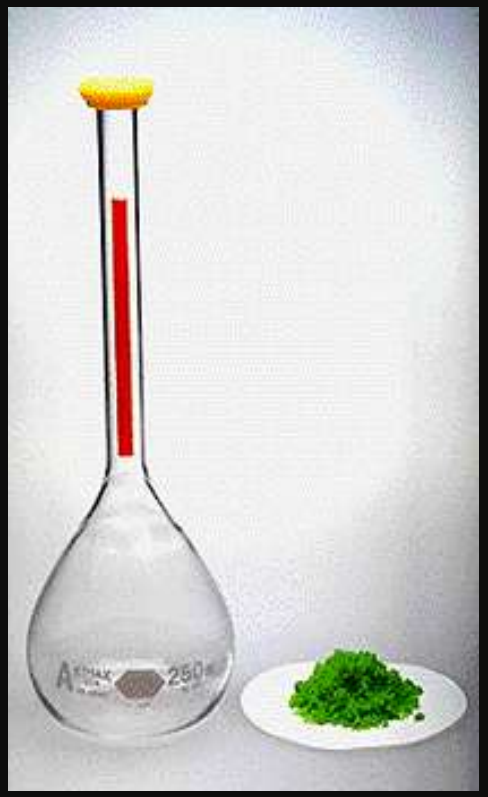
$$\text{Molarity (M)} = \frac{\text{moles solute}}{\text{liters of solution}}$$

1.0 L of water was used to make 1.0 L of solution. Notice the water left over.



Practice

Dissolve 5.00 g of $NiCl_2$ in enough water to make 250 mL of solution. Calculate the Molarity.



Dissolve 5.00 g of $NiCl_2$ in enough water to make 250 mL of solution. Calculate the Molarity.

Step 1: Calc. moles of $NiCl_2$

$$5.00\ \text{g} \bullet \frac{1\ \text{mol}}{129\ \text{g}} = 0.0388\ \text{mol}$$

Step 2: Calculate Molarity

$$\frac{0.0388\ \text{mol}}{0.250\ \text{L}} = 0.155\ \text{M}$$

$[NiCl_2]$ = 0.155 M

Determining Morality Mini Lab

- Follow instructions exactly as written.
- If asked to add 30ml of water add 30ml of water
- No Pre-Lab!

Molarity and temp

Moles of $CoCl_2 \cdot 6H_2O$	Volume solution	Molarity	temp

With so many variations for representing concentrations of liquid solutions, why is it important for you to understand what each is representing

Using Molarity

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250. mL of a 0.0500 M solution?

moles = mol/L x Vol

Using Molarity

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250. mL of a 0.05 M solution?

moles = mol/L x L

Step 1: mL → L.

250 mL x 1L/1000mL = 0.250 L

Step 2: Calculate.

Mol=(0.05 mol/L) (0.250 L) = 0.0125 mol

Step 3: Convert moles → grams.

(0.0125 mol)(90.00 g/mol) = 1.13 g

Practice makes Perfect

Calculate the molarity when 75.0g of $MgCl_2$ is dissolved in 500.0 mL of solution.

100.0g of sucrose ($C_{12}H_{22}O_{11}$)is dissolved in 1.50 L of solution. What is the molarity?

49.8g of KI is dissolved in enough water to make 1.00 L of solution. What is the molarity?

A chemist dissolves 98.4g of $FeSO_4$ in enough water to make 2.000 L of solution. What is the molarity of the solution?

Two Other Concentration Units

MOLALITY, *m*

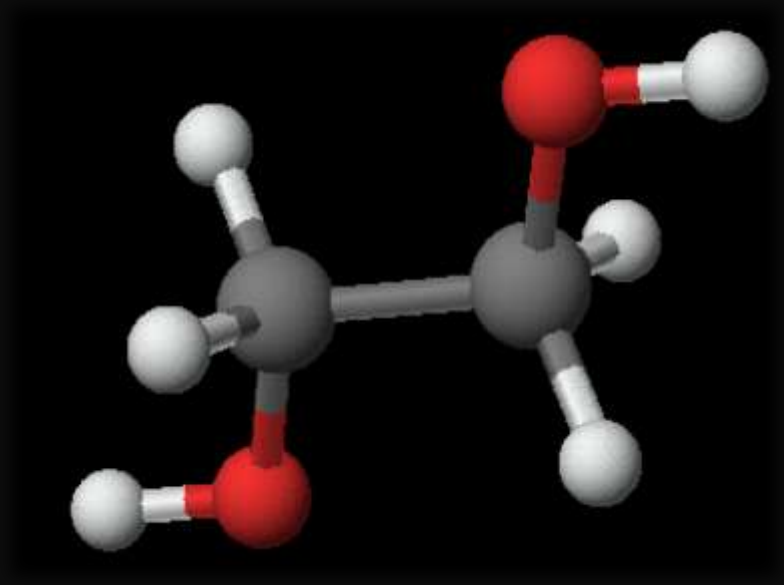
$$m \text{ of solution} = \frac{\text{mol solute}}{\text{kilograms solvent}}$$

% by mass

$$\%\ \text{by mass} = \frac{\text{grams solute}}{\text{grams solution}}$$

Calculating Concentrations

Dissolve 62.1 g of ethylene glycol in 250.0 g of H_2O. Calculate molality *and* % by mass of ethylene glycol ($C_2H_4(OH)_2$).



Calculating Concentrations

Dissolve 62 g of ethylene glycol, $C_2H_4(OH)_2$, in 250g of H_2O and Calculate the m and % mass (by mass) of $C_2H_4(OH)_2$

Calculate molality

Conc. (molality): $$\frac{1.00 \text{ mol glycol}}{0.25\text{kg } H_2O} = 4.0\text{molal}$$

Calculate weight %

$$\% \text{ glycol} = \frac{62\text{g}}{62\text{g} + 250\text{g}} \times 100\% = 19.9\%$$

Learning Check

A solution contains 15g Na_2CO_3 and 235g of H_2O. What is the mass % of the solution?

1) 15% Na_2CO_3

2) 6.4% Na_2CO_3

3) 6.0% Na_2CO_3

Practice makes Perfect

What is the *molality* of a solution made by dissolving 0.1356 g $MgSO_4$ in 200.0 mL of water?

What is the volume of 3.0 M solution of NaCl made with 526g of solute?

Battery acid is generally 3M H_2SO_4. Roughly how many grams of H_2SO_4 are in 400. mL of this solution?

How many grams of $Sr(ClO_4)_2$ are required to make a 0.30 *m* aqueous solution using 600 g of water?

Lab Time
"Molarity Practice Lab"

First and foremost do not break the volumetric flasks!

Each person must "make" at least one of the 2 solutions

Do all the calculation before we go into lab for your chemical set

And we will not be doing a full pre lab!!!!

Lab Time
"Molarity Practice Lab"

$$\%\ \text{by m/v} = \frac{\text{grams}_{\text{solute}}}{100\text{mL}_{\text{solution}}}$$

So… if we wanted a 100ml of 5.0%solution of $NiCl_2 \cdot 6H_2O$ we would:

Weight out: 0.05 = x / 100mL

x = 5.0g

Add 5.0g to 100ml volumetric flask and fill *to* 100ml with DI water

Lab Time
"Molarity Practice Lab"

Disposal:

Down sink

Homework

Molarity Practice #1-10,

Due Monday 18.April.2016

A tough one!

How many grams of $BiCl_3$ are needed to make 500.0 g of a 0.10*m* aqueous solution?

Hint: $g_{solution} = g_{solvent} + g_{solute}$

$0.5kg = g_{solvent} + g_{solute}$

Find grams of solute based on the given info… use algebra!

Bell Work
15-April-2016

What is the molality of a solution made with 45g of NaCl and 3 000g of water.

What is the percent mass of the solution?

Bell Work
18-April-2016

When you have 100mL of a 0.5M solution of NaOH, how many mole of NaOH are present?

If 450mL of water is added what is the new molarity?

How does temperature affect solubility of solids in liquids? Give an example.
Gasses in liquids? Give an example

Turn in

“Molarity Practice” Lab

Making Solutions

Molarity Practice Home Work (table and #1-10)

Agenda:

Dilutions

Finish Polarity

Objective: you will understand how to use the dilutions formula and apply it in a laboratory setting

DILUTION

Going from one concentration to another

$$M_1V_1=M_2V_2$$

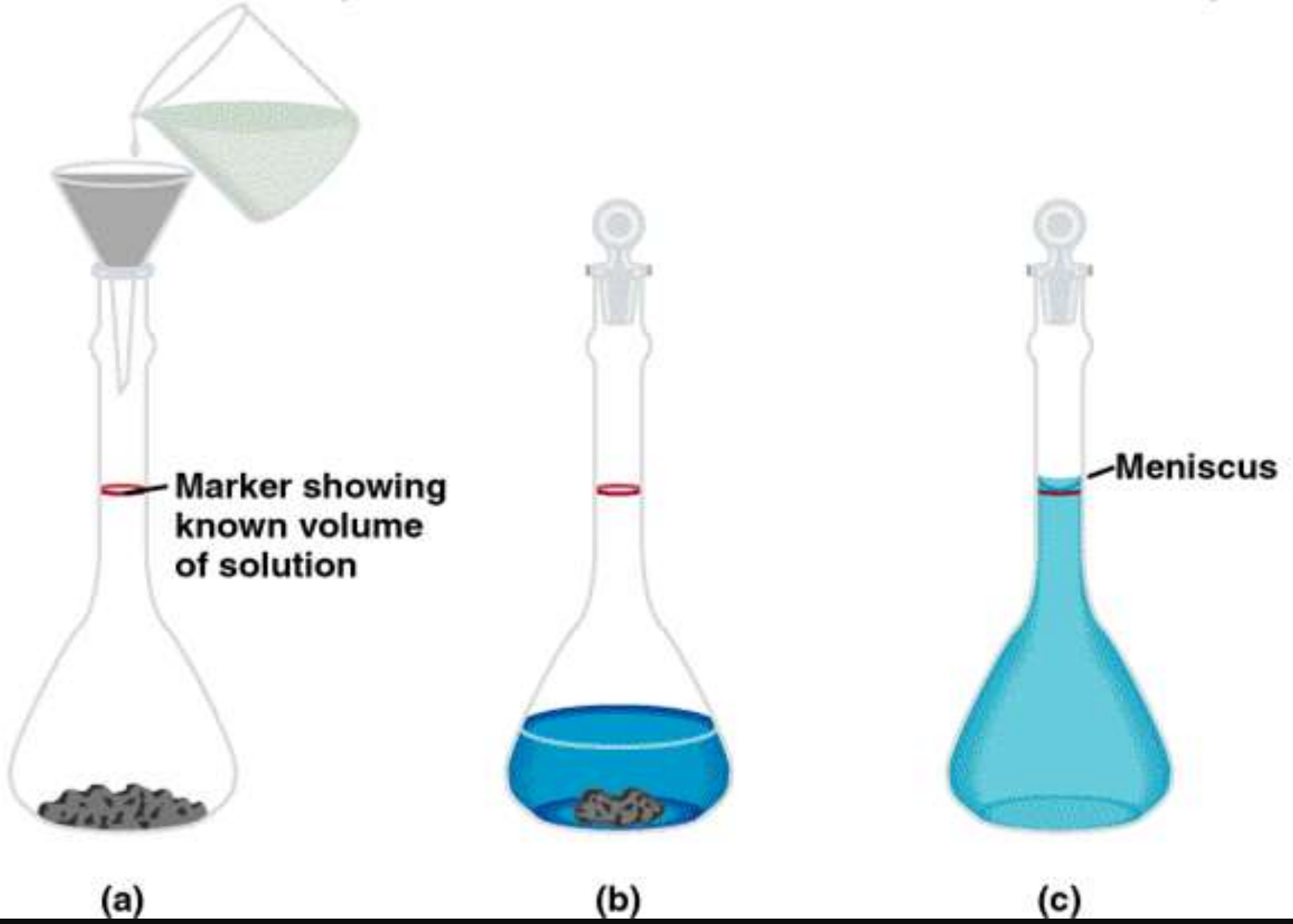
M = molarity (mol/L)

V = volume (what unit ????)

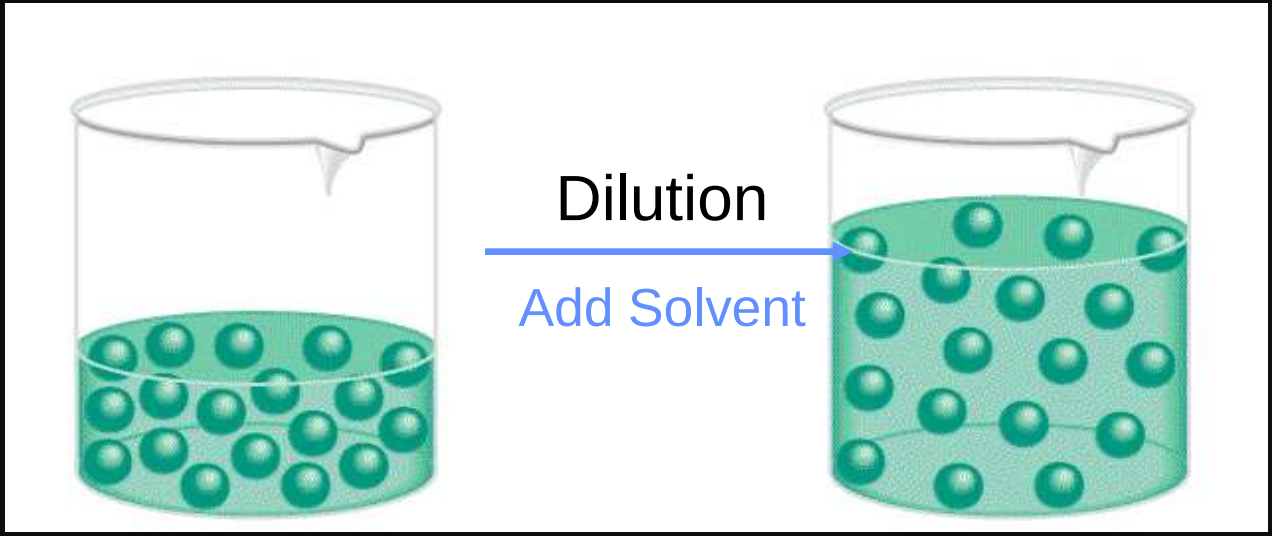
Starting/ what you have M_1 and V_1

Ending/ what you want M_2 and V_2

Preparing a Solution of Known Molarity



Dilution is the procedure for preparing a less concentrated solution from a more concentrated solution.



Moles of solute before dilution (i) = Moles of solute after dilution (f)

$M_1V_1 = M_2V_2$

How would you prepare 60.0 mL of 0.2*M* HNO_3 from a stock solution of 4.00 *M* HNO_3?

$$M_1V_1 = M_2V_2$$

M_1 = 4.00M M_2 = 0.200M V_2 = 0.06 L V_1 = ? L

$$V_1 = \frac{M_2V_2}{M_1} = \frac{0.200M \times 0.06L}{4.00M} = 0.003\ L = 3\ mL$$

3 mL of acid + 57 mL of water = 60 mL of solution

DILUTION

What would the new molarity be of a 250ml 0.8M solution of HCl if it was diluted to 450ml?

Bell Work
21-April-2016

Describe in 2-3 sentences with supporting evidence (formulas, gas law relationships, etc.) how you could determine the pressure of a gas collected over water?

Lab Time

Killa Kool Aid!!!

Lab Time

Killa Kool Aid!!!

Group	New Molarity Red 2.20M	Blue 1.50M	Green 3.60M	mL of killer Kool aid needed			Observations
1	0.176	0.135	0.324				
2	0.110	0.105	0.216				
3	0.088	0.075	0.180				
4	0.066	0.045	0.144				
5	0.44	0.30	0.72				

So, group 1 does dilutions for Red 2.2M→ 0.176, Blue 1.50M→ 0.135M, Green 3.60M → 0.324M.

Kool-Aid the Molar Solutions

A. If a 2.00L solution contains 200.0g of sugar (MM 180.0g/mol), what is the molarity of a Kool-Aid Drink?

B. What is the molarity of a 330mL glass of Kool aid made using the 50mL of the 2.0L Kool-Aid you made in the previous problem?

Practice

What is the molarity of a solution with 2.0 grams of NaOH dissolved to a volume of 300ml in water. What would be the new molarity if you diluted to solution of 630ml?